

## SLEEP DETECTION AND DRIVER ALERT APPARATUS

### RELATED APPLICATIONS AND DISCLOSURE DOCUMENTS

This application is a continuation in part of the invention described in application Ser. No. 08/432,419, filed Apr. 24, 1995, and now abandoned.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates generally to sleep detection devices, and, more particularly, to an apparatus to detect the early stages of sleep in a driver of a motor vehicle which provides an alarm means for warning and/or waking the driver.

#### 2. Description of the Related Art

As is well-known in the art, a number of different physical phenomena can be monitored and measured in order to detect the onset of sleep in the driver of a vehicle. Simple devices, such as foot switches which must be kept activated by a driver's foot, or electrical contacts attached to the eyelids of drivers to detect closing of the driver's eyes have proved to be ineffective due to one or more major shortcomings. Primarily, those devices which required direct physical contact with the driver tend to be awkward, uncomfortable, or inconvenient, and thereby end up ineffective due to their disuse in practice.

Another problem occurs from devices that attempt to detect driver sleepiness by monitoring indirect evidence of sleep. Particularly, by monitoring of the position of the steering wheel, by measuring the driver's grip on the steering wheel, by counting blinks, or merely by attempting to measure the position of the driver's eyelids have all been used unsuccessfully to detect sleepiness in a driver of a motor vehicle.

Numerous attempts have been made to correct the foregoing problems. For instance, U.S. Pat. No. 3,631,446, issued in the name of Setner, discloses a sleep-sensing device for use on automobile vehicles. However, a sleep-sensing device for use on automobile vehicles made in accordance with this reference is associated with several drawbacks. For example, the Setner reference discloses a method of detecting sleep in a driver by monitoring normal movement of the vehicle's steering wheel. However, this reference is prone to false alarms in that it does not allow for long, straight, smooth sections of highway. These are the very situations that are likely to contribute to drowsiness in a driver. Moreover, such a device is not readily adaptable to other vehicle operations, such as airplanes, where vehicle speed or wheel movement patterns are completely different than those for an automobile.

Additionally, U.S. Pat. No. 3,678,494 also issued in the name of Setner discloses a sleep sensing apparatus for use on automotive vehicles. This second Setner reference discloses a programmable device that also monitors the vehicle's steering wheel activity, but allows for variances that result at different vehicle speeds.

In U.S. Pat. No. 4,210,905 issued in the name of Coons, an alarm for waking a dozing driver is disclosed. The Coons reference discloses a plurality of electrical switches arranged about a steering wheel of a vehicle which require the driver to maintain a constant firm grasp on the wheel to prevent an alarm from sounding. The Coons reference increases effort and fatigue on the driver and fails to accommodate toll gates,

parking lots, or other situations where the driver may want or need to remove both hands from the wheel, at least momentarily.

In U.S. Pat. No. 4,564,833 issued in the name of Seko et al., a dozing warning system for a vehicle is disclosed. In the Seko et al. reference, a device is disclosed which provides pulses indicative of the steering angle and steering direction, and monitors such pulses for comparison in order to determine that a driver is sleeping. Once again, the Seko et al. reference relies on indirect evidence of sleep, i.e. it monitors operation of the vehicle and not the driver.

In U.S. Pat. No. 4,875,030 issued in the name of Chiu, a sleep preventing alarm device is disclosed. In the Chiu reference, the preferred embodiment is contained in a device that resembles a pair of reading glasses which is then worn by the user. In the Chiu reference, the position of the wearer's eyelids are monitored, and a buzzer is sounded in the wearer's ear if the eyelids remain closed past a predetermined period of time. However, a major problem with the Chiu reference is that it must, at the very least, be worn by the user in order to be effective.

Finally, in U.S. Pat. No. 4,953,111 issued in the name of Yamamoto et al., a doze detector is disclosed which reference the use of two reflection type sensors to detect blinks of the user's eyes. As with Yamamoto et al and other references, blinking is the only measure of sleepiness which is utilized, and the sensors must remain in close proximity to the user.

Consequently, a need has been felt for providing an apparatus and method which overcomes the problems associated with monitoring vehicular functioning rather than direct evidence of sleep itself. Additionally, a need has been felt to provide such an apparatus and method which overcomes the problems associated with direct contact or user worn devices.

### SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an improved sleep detection and driver alert apparatus.

It is a further object of the present invention to provide an improved sleep detection and driver alert apparatus that may be suited to be attached to the rear view mirror or upon the vehicle dash board.

It is a further object of the present invention to provide an improved sleep detection and driver alert apparatus that utilizes digital infrared auto-focus image stabilization zoom camera lens technology to maintain a physically remote monitoring of a user's eye-nose area, thereby eliminating the need for a user worn or a close proximity device.

It is a further object of the present invention to provide an improved sleep detection and driver alert apparatus that measures and determines changes in heat output between open eyes and closed eyes via pixel color change with infrared imaging.

It is a further object of the present invention to provide an improved sleep detection and driver alert apparatus that measures and determines changes in heat output from changes in respiration via an infrared thermal sensor.

It is a further object of the present invention to provide an improved sleep detection and driver alert apparatus that can provide an escalating series of audible alarms in order to awaken or alert a sleepy driver.

It is a further object of the present invention to provide an improved sleep detection and driver alert apparatus that is self calibrating to assure proper operation with users of different size, height, and other physical characteristic.